






ORIGINAL RESEARCH

Radiofrequency ablation compared to surgery for thyroid nodules: A case for office based treatment

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Abstract

Objective: We aim to evaluate the safety and effectiveness of radiofrequency ablation (RFA) for benign thyroid nodules by ENT surgeons and to compare it to conventional hemithyroidectomy in the public healthcare, operating theater contained setting.

Methods: 50 patients who underwent a single session of RFA for symptomatic benign thyroid nodules in Prince of Wales Hospital and Tseung Kwan O Hospital in Hong Kong from 2020 to 2022 were evaluated. Objective outcomes including nodule volume, volume reduction rate (VRR) and complications were recorded. Subjective response in the form of a 0–10 point scale for patient symptoms including obstructive, cosmetic, pain and satisfaction scores were collected.

Results: Significant reduction in mean VRR was found at 3, 6 and 12 months post treatment, accompanied by a significant reduction in the mean obstructive and cosmetic symptom scores. Comparing with conventional hemithyroidectomy, the RFA group had a significantly shorter mean procedure time and lower rate of complications. Estimated cost to patient for RFA was found to be less than half of that of hemithyroidectomy.

Conclusion: RFA is a safe and effective treatment modality for benign thyroid nodules by ENT surgeons with advantages of being a scarless local anesthetic procedure with shorter procedure time, lower complication rate and lower cost to patient compared to hemithyroidectomy. In Hong Kong, where most of the population is treated in the public sector, there are limited resources, often with high caseload burden and long operation waiting times. Therefore, RFA is an office-based treatment that serves as a valuable alternative to hemithyroidectomy for benign nodules, especially in lower resource settings.

Level of evidence: 3.

KEYWORDS

hemithyroidectomy, RFA, thyroid nodules

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1 | BACKGROUND

Thyroid nodules are common in adults, with an estimated prevalence of 50% in adult females and 30% in males in ultrasound examination in literature.¹ While the majority are benign and asymptomatic, a non-negligible number of patient present to the ENT clinic complaining of local symptoms, usually cosmetic or obstructive in nature. Conventionally, these patients are offered surgery in the form hemithyroidectomy. While it has the advantages of enabling complete removal and histological analysis of the thyroid nodule, it is not without its shortcomings. To the patient, it is an invasive general anesthetic procedure with potential risks of debilitating complications such as recurrent laryngeal nerve palsy, hypothyroidism or unsightly scar. To the healthcare provider, there are concerns of cost and resource allocation for limited general anesthesia operating theater lists.

This is especially important in Hong Kong, where most patients are treated in the public sector. Resources are limited, and there is a growing need to provide treatment modalities that require less time, cost less, free up resources but are effective and acceptable to patients. Efficiency of resource utilization is essential to provide uniformly the best level of care to the maximum number of patients.

Non-surgical methods of treatment for benign thyroid nodules have been gaining popularity, including image guided ethanol ablation (EA) and various thermal ablation (TA) modalities such as laser ablation (LA), radiofrequency ablation (RFA), microwave ablation (MWA) and high-intensity focused ultrasound (HIFU). RFA is one of the more thoroughly assessed TA modalities for benign thyroid nodules in literature, with multiple studies reporting on its clinical efficacy and safety as well as several guidelines and consensus statements published from various countries to guide its appropriate use in clinical practice.¹⁻⁴ It delivers a high-frequency alternating current from 200 to 1200 kHz to generate heat, leading to coagulative necrosis and reduction in size of the thyroid nodule.⁵

Image guided procedures have typically been performed by radiologists and most of the evidence on RFA for thyroid nodules are based on radiologist performed results. However, the use of ultrasound and ultrasound related procedures have become increasingly common in the clinical practice of the ENT surgeon. Surgeon performed US-FNAC for thyroid nodules have been shown to be comparable with results by radiologists in literature.^{6,7} In this study, we sought to assess the efficacy and safety of ENT surgeon performed RFA for benign thyroid nodules, to compare it with conventional surgery and evaluate it as an alternative treatment modality in the resource limited public sector of Hong Kong.

2 | METHODS

The evaluation of RFA outcomes and comparison to surgery were both approved by The Joint CUHK-NTEC CREC, (2021.512) and KEC Ethics Committee (KC/KE-21-0249/ER-2).

2.1 | RFA protocol and outcome measures

US guided RFA is an offered modality of treatment for benign, symptomatic thyroid nodules by the Department of Otorhinolaryngology, Head and Neck Surgery in the Prince of Wales Hospital and Tseung Kwan O Hospital in Hong Kong. All cases are performed by ENT surgeons in the Head and Neck Team with experience in ultrasound operation. We evaluated cases of benign thyroid nodules treated with a single session of RFA from 2020 to 2022 in these two ENT centers. Patients were included if they were >18 years of age, had a symptomatic single thyroid nodule or dominant nodule of multinodular goiter (MNG), had nodule size >2 cm and had benign cytology confirmed by US-FNAC. Patients were excluded if they were asymptomatic, had high risk ultrasound or cytology features, had toxic nodules or MNG, retrosternal goiters and had bleeding tendency or on anticoagulants. All patients followed the same protocol, based on the 2020 European Thyroid Ablation Clinical Practice Guideline.¹ Pre-ablation, patients had an ultrasound evaluation by a radiologist and blood tests including platelet count, clotting profile, and thyroid function. The size and volume of the target nodule was measured and recorded and a FNA was performed to confirm benign cytology. The nodule composition was documented and stratified into solid, spongiform, and cystic with reference to ACR TI-RADS criteria,⁸ with cystic nodules including the mixed solid-cystic type. Prior to RFA, patients were asked to rate their cosmetic and obstructive symptom score from a visual analogue scale (VAS) from 0 to 10 where 10 is most severe.

All cases of RFA were performed in a day surgery operation theater under local anesthesia following local hospital protocols. Patients were given IV midazolam for sedation and monitored. Local anesthesia with 2% lignocaine with 1:80000 adrenaline using a 22-gauge spinal needle was first injected into the thyroid capsule under ultrasound guidance. The RFA needle was then inserted via the trans-isthmus approach and the nodule was ablated using the “moving-shot technique” as described by Baek et al.⁹ In our centers, the RFA device used is the AKPro CoAtherm 7 mm probe. Care is taken throughout the procedure to avoid the danger triangle, to prevent inadvertent injury to the recurrent laryngeal nerve. After the procedure, an ice-pack is applied to the neck for 10 min and the patient is monitored for 2 h prior to discharge on the same day with analgesics, to be taken if needed.¹⁰ The patient is also asked to rate the level of pain from the procedure from a VAS from 0 to 10, where 10 is most severe.

Patients were followed up first at 2 weeks for a flexible laryngoscopy examination to check the vocal cord status, then at 3, 6, 12 months. On each follow up, patients were asked to give their cosmetic and obstructive symptom score and the volume of the nodule was measured by ultrasound. The ablation site was examined on each follow up and the skin condition and presence of any scarring was noted. At 3 months follow up, blood analysis for thyroid function was performed. Patients were asked to give their satisfaction score from 0 to 10 at the 6-month follow-up.

Both objective and subjective outcome measures were recorded. Objective outcome measures included nodule volume (mL) and volume reduction rate at 3, 6, 12 months. Volume reduction rate (VRR) was calculated by the formula: $VRR = (\text{initial} - \text{current volume}) \times 100/\text{initial}$

volume. Complications were recorded and classified according to the Clavien Dindo classification into minor (Clavien Dindo I-II) and major (Clavien Dindo III+). Complications were classified in this manner for a more direct comparison with conventional surgery. Subjective outcome measures included patient symptom, pain and satisfaction scores to assess patient tolerability to the procedure.

2.2 | Comparison with surgery

The RFA was then compared to a historical cohort of patients with hemithyroidectomy done for benign thyroid nodules from 2017 to 2021 in the same two ENT centers, matched for patient age, gender and nodule volume. Inclusion criteria included open hemithyroidectomy with final benign pathology. Patients were excluded if the thyroid nodule was found to be malignant, toxic or part of a retrosternal goiter. Remote access hemithyroidectomy and hemithyroidectomy done as part of a more extended surgery such as laryngectomy were also excluded.

Standard open hemithyroidectomy under general anesthesia was performed with the follow steps.¹¹ Collar incision 1.5–2 finger breadths above the clavicular heads is made. After dissection of the strap muscles from the thyroid gland, the upper pole of the thyroid is exposed and the superior pedicle is ligated below the external laryngeal nerve. After releasing the upper pole, the thyroid lobe is rotated medially by separating the remaining alveolar tissue between the gland and the sternothyroid muscle to expose the tracheo-esophageal region. An attempt is made to identify and preserve the inferior parathyroid glands. The branches of the inferior thyroid artery are divided close to the capsule to preserve blood supply to the parathyroid glands. After the lower pole is released, the recurrent laryngeal nerve is identified lying within the tracheo-esophageal groove and traced cranially until it enters into the larynx. The berry's ligament is carefully divided and the thyroid lobe is dissected off the trachea, the isthmus is coagulated or divided and oversewn. The strap muscles are approximated and the wound is closed.

Outcomes for comparison between the RFA group included duration of procedure (mins), cost to patient (HKD) and complication rate. Duration of procedure was the recorded skin to skin time of operation, be it RFA or hemithyroidectomy. This was selected over on time to provide more fair comparison with conventional surgery. The complication rate for the hemithyroidectomy patients were recorded and classified by the Clavien-Dindo classification in identical fashion to the RFA group. The cost to patient was calculated by the mean of the gazette cost of the local public healthcare body and quoted costs from two other insurance companies. This was obtained for both hemithyroidectomy and RFA.

2.3 | Statistics

Statistical analysis was performed using SPSS version 29. The means of continuous variables were compared with Wilcoxon signed rank test within the RFA group and Mann-Whitney *U* test was used to compare the continuous variables between the RFA group and hemithyroidectomy group for statistical differences. Categorical variables were

TABLE 1 RFA group demographics.

Baseline characteristics	
Mean age (years) (SD)	52.4 (±12.3)
Gender	Female: 41 Male: 9
Mean initial volume (mL)	15.2 ± 12.3
Mean initial obstructive score (SD)	4.3 (± 2.7)
Mean initial cosmetic score (SD)	4.9 (± 2.4)
Nodule type	Cystic: 4 Spongiform: 29 Solid: 17
Location	Right: 30 Left: 18 Isthmus: 2

compared using Chi-Square test. *p* values <.05 were considered as statistically significant. Multiple regression analysis was also performed to evaluate for predictive variables of outcome measures.

3 | RESULTS

3.1 | RFA group

50 patients who had undergone a single session of RFA for benign thyroid nodules were evaluated. The group was female predominant, with 41 females and 9 males, with a mean age of 52.4 years of age. All patients had normal thyroid function, platelet count and clotting profile in the pre-ablation blood analysis. Table 1 summarizes the baseline characteristics of the RFA group, including the nodule volume, type, location and initial symptom scores.

There is a statistically significant increase in the VRR at each follow up ($p < .001$) which progressively increased up until the 1 year follow up, with a mean VRR of 77% at 1 year. This data is summarized in Table 2 and the VRR trend is shown in Figure 1. Multiple regression analysis was performed to evaluate for any predictors for VRR at 3 months, 6 months and 1 year. Gender, initial volume and nodule type were evaluated, but none of them showed any statistical significance.

Like the volume of the nodule, the patient's mean symptoms scores reduced significantly after RFA ($p < .001$). This reduction was progressive with each follow up and culminated at a mean of 0.5 out of 10 for both obstructive and cosmetic scores at the 1 year follow up. These results are shown in Table 3, Figures 2 and 3. The mean pain score was 3 out of 10 while the mean satisfaction score was 9 out of 10.

3.2 | RFA group compared with hemithyroidectomy group

35 cases of hemithyroidectomy for benign thyroid nodules were identified from 2017 to 2021. Compared with the hemithyroidectomy group, there was no statistical significance in age, volume and gender. This is summarized in Table 4.

TABLE 2 Volume reduction rate at each follow-up.

	Initial	3 months	6 months	1 year
Mean VRR (%)	0	61.3% ± 18.5% (n = 45) <i>p</i> < .001	69.1% ± 19.7% (n = 45) <i>p</i> < .001	76.6% ± 17.4% (n = 30) <i>p</i> < .001

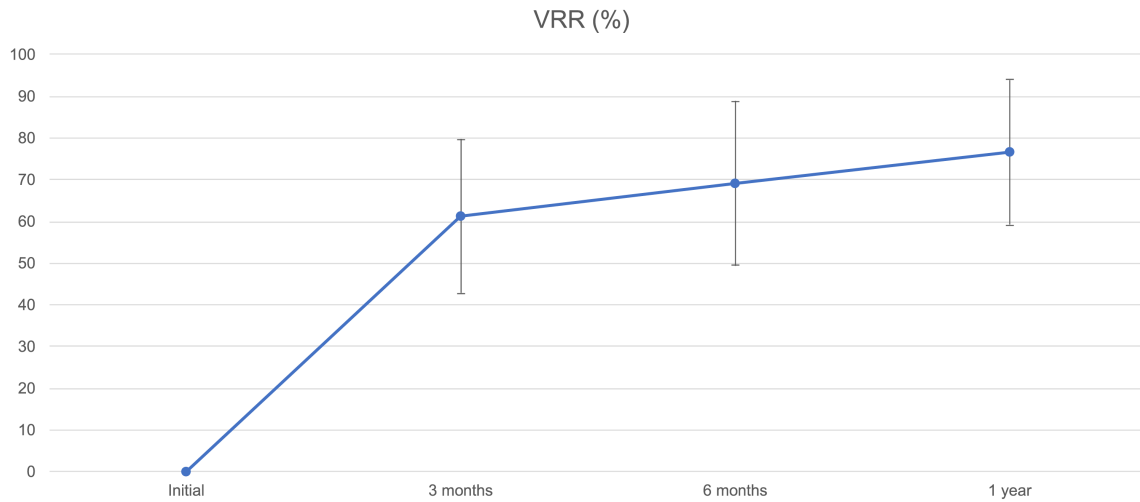


FIGURE 1 Trend of VRR.

TABLE 3 Obstructive symptom scores at each follow-up.

Mean symptom scores mean ± SD median [min, max]	Initial	3 months	6 months	1 year
Obstructive score	4.3 ± 2.7 (n = 49) 5 [0,10]	1.1 ± 1.7 (n = 44) 0 [0,7] <i>p</i> < .001	0.4 ± 0.9 (n = 45) 0 [0,4] <i>p</i> < .001	0.7 ± 2.1 (n = 29) 0 [0,10] <i>p</i> < .001
Cosmetic score	4.9 ± 2.4 (n = 49) 5 [0,10]	1.4 ± 1.9 (n = 44) 0 [0,7] <i>p</i> < .001	0.8 ± 1.5 (n = 45) 0 [0,6] <i>p</i> < .001	0.6 ± 1 (n = 29) 0 [0,3] <i>p</i> < .001

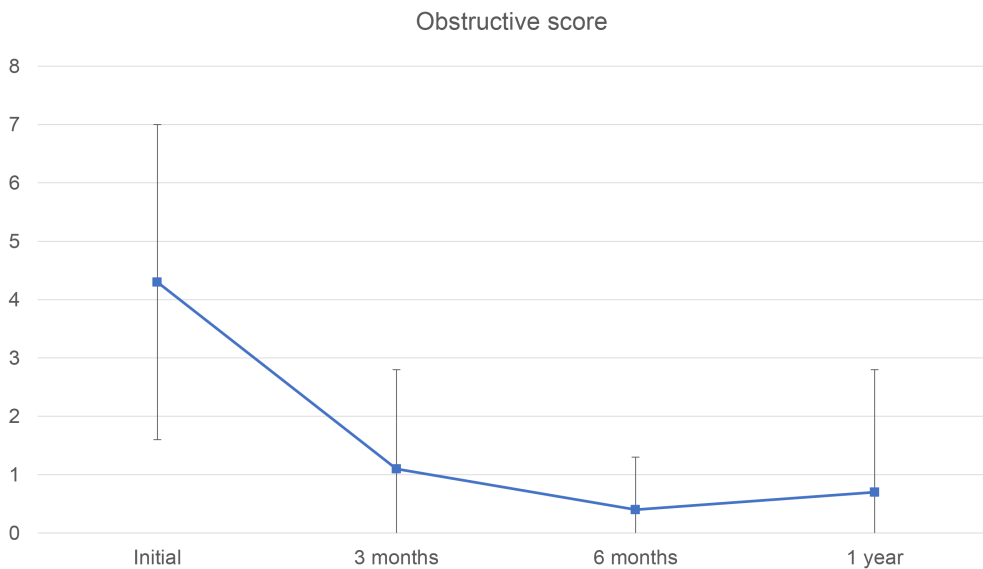


FIGURE 2 Trend of patient obstructive symptom score.

FIGURE 3 Trend of patient cosmetic symptom score.

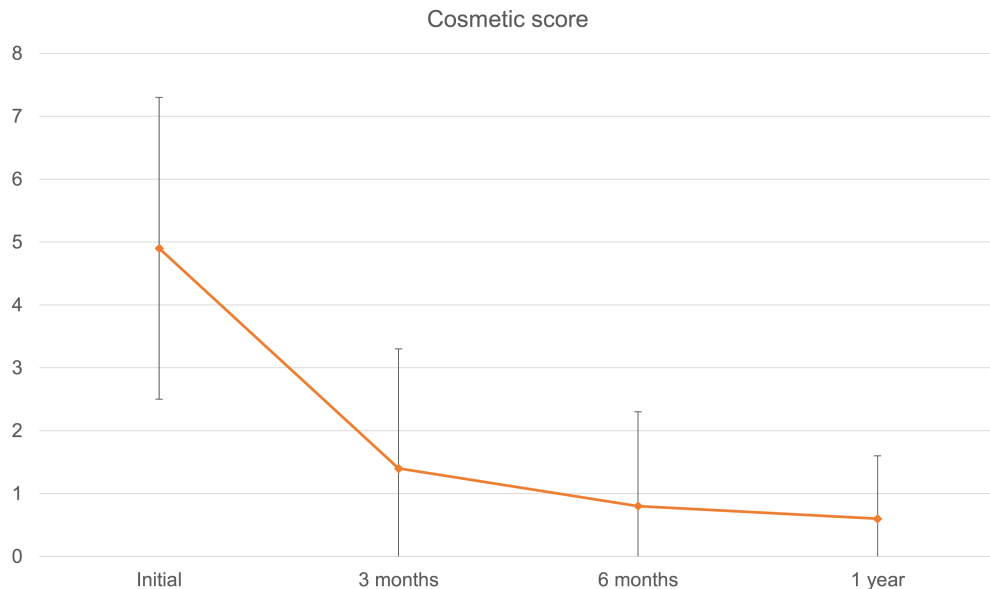


TABLE 4 Comparison between RFA and hemithyroidectomy group.

		N	Mean	Std. deviation	p value
Initial nodule volume (mL)	RFA	50	15.2	13.6	.247
	Hemithyroidectomy	33	16.6	20.6	
Duration of procedure (mins)	RFA	50	42.7	17.0	<.001
	Hemithyroidectomy	35	112.7	41.6	
Age (years)	RFA	50	52.4	11.1	.765
	Hemithyroidectomy	35	53.7	16.0	
	RFA			Hemithyroidectomy	
Female	41			27	
Male	9			8	

Note: p value = .582.

TABLE 5 Summary of comparison of complications between RFA and hemithyroidectomy group.

Complications	RFA	Hemithyroidectomy
Major	0%	0%
Minor	4/50 (8%) <ul style="list-style-type: none"> • Transient neck swelling and bruising (6%) • Transient vocal cord palsy 1/50 (2%) • Hypothyroidism (0%) • Skin changes or scar (0%) 	13/35 (37.1%) <ul style="list-style-type: none"> • Pitch changes (5.7%) • Transient vocal cord palsy (5.7%) • Subclinical hypothyroidism (8.6%) • Hypothyroidism requiring replacement (2.8%) • Wound complications (8.6%) • Scar complications (5.7%)

TABLE 6 Comparison of cost to patient between RFA and hemithyroidectomy group.

Cost to patient	RFA (HKD)	Hemithyroidectomy (HKD)
Hospital Authority Gazette Cost	14,600	43,700
Insurance company 1 quote	30,000	100,000
Insurance company 2 quote	42,425	78,050
Mean	29,008 (3696 USD)	73,917 (9418 USD)

The RFA group was found to have a significantly shorter mean procedure time at 43 min opposed to 112 min in the hemithyroidectomy group ($p < .001$). The cost to patient for RFA was also less than

half of that of the hemithyroidectomy group, at 29,008 HKD (3696 USD) compared to 73,917 HKD (9418 USD). Table 5 depicts the comparison of complications between RFA and hemithyroidectomy and Table 6 shows the cost comparison. There were no major complications in either group. Overall, RFA had a significantly lower rate of complications at 8% compared to 37.1% ($p < .05$). There was one case

of transient vocal cord palsy which recovered the next day after observation. The other complications in the RFA group included transient neck swelling and bruising. There were no visible scars or permanent skin complications in the RFA group. In comparison, there was a 5.7% rate of scar complications in the hemithyroidectomy group and 5.7% rate of transient vocal cord palsy which recovered 3–4 months post operatively.

4 | DISCUSSION

In Hong Kong, where most of the population is treated in the public sector, the overwhelming number patients with symptomatic benign thyroid nodules presents a challenge to the healthcare provider, both in terms of the long waiting time and the resources required to manage all these patients with surgery requiring a general anesthetic. There is an increasing need to provide a time and cost-efficient strategy without sacrificing effectiveness and patient tolerability to manage this large population of patients in Hong Kong public hospitals, where resource limitation is a legitimate concern. With the growing evidence of efficacy and advantages of RFA, especially its potential as a local anesthetic outpatient or office-based procedure, it could be an effective alternative form of treatment to address these challenges. It is therefore important for ENT surgeons to become familiar with this treatment modality to better counsel and treat symptomatic benign thyroid patients.

RFA of benign thyroid nodules have been shown to be effective and safe in reducing nodule volume, with results persisting up to 5 years in literature.¹² These results have been reproduced by different groups, with a VRR ranging from 50% to 94%,⁵ with some studies involving multiple sessions of RFA. Other thermal ablation modalities have also been described, including microwave and laser ablation. Less literature is available on microwave ablation, with more variable reported volume reduction results in literature, ranging from 45% at 12 months to 65% at 6 months.¹³ Laser ablation has shown similar lasting volume reduction to RFA, albeit with higher rates of regrowth and reablation.¹⁴ We have obtained similar results, with a mean VRR of 77% at 1 year after a single session of RFA, accompanied by a significant improvement in patient symptom scores. Some studies have found that VRR is affected by nodule type and initial volume, with a higher therapeutic success in smaller and more cystic nodules.¹⁵ However, in our current data, nodule type and volume were not statistically significant predictors, although this may be limited by sample size. In our series, there is a low complication rate, with one case of transient vocal cord palsy. More serious complications such as permanent vocal cord palsy, nodule rupture and hematoma associated with RFA have also been described in literature,¹⁵ albeit at a low rate, which must be considered.

Our results also show distinct advantages of RFA over conventional surgery for benign thyroid nodules, with a significantly lower complication rate, procedure time and cost to patient in Hong Kong. Importantly, it can be done under local anesthesia and requires no hospital stay. The cost advantages of RFA compared to conventional

surgery have been also recently described by Ayoub et al., with a similar finding of surgery costing more than double compared with RFA.¹⁶ Kuo et al. have also shown RFA to be a cost-effective strategy in the United States.¹⁷

Furthermore, despite our best efforts, conventional surgery also invariably produces a scar, compared to RFA, which has no visible skin changes. These factors have important implications in our public healthcare system, with the potential of significantly reducing waiting time, freeing up valuable operation theater sessions and resources for the treatment of malignant conditions, whilst maintaining good outcomes and improving patient satisfaction. However, it is important to note that RFA cannot replace surgery, especially if histology needs to be obtained. RFA should also not be performed in pregnant patients, those with pacemakers or bleeding tendencies. These may all be important considerations to the patient seeking treatment for this common condition.

There are several limitations to our study, namely the relatively small sample size, short follow up time and the retrospective comparison with hemithyroidectomy. This may lead to bias and variability in our results. For example, while previous studies have shown significantly more pronounced VRR in smaller cystic nodules compared to larger solid nodules, our data did not show this. In addition, although RFA has been shown to have a shorter procedure time, it may be underestimated, as the time for administering general anesthesia, post-operative monitoring, and perioperative set up were not included for hemithyroidectomy patients. Despite providing valuable cost comparisons between RFA and hemithyroidectomy, our cost calculations may not fully complete as it does not include associated personnel costs, although that would likely further exaggerate the cost difference due to the requirement of an anesthetist in hemithyroidectomy.

Nodule regrowth is a growing concern, especially in the long-term, and may require additional ablative treatments.¹⁸ While this has not yet been encountered in our series, it may be due to the relatively short follow up, as most cases of nodule regrowth occur beyond 1 year post procedure. Nevertheless, our data confirms the reproducibility of effective and safe RFA results by ENT surgeons with ultrasound experience and provides valuable comparisons with conventional surgery.

5 | CONCLUSION

Our study represents local data in public hospitals in Hong Kong of a single session of RFA for benign thyroid nodules and compares it to conventional surgery. It confirms that it is an effective and safe procedure by ENT surgeons, and compared to conventional hemithyroidectomy, it has a shorter procedure time, lower cost to patient and lower complication rate. Importantly, it can be performed under local anesthesia without a surgical scar and without the need for hospital stay, which may be preferred by the patient or significant to the healthcare provider in resource allocation. This is especially valuable in the low resource setting of the public sector, where resource allocation, cost and time is key. While surgery is still valuable, especially to

obtain formal histology, we believe that RFA should be part of the armamentarium of the ENT surgeon as an alternative modality.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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